

Recent Observations of the Rings of Saturn, and their bearing upon some of the Phenomena of the Disappearance of the Rings in 1907. By E. E. Barnard.

In *A.N.* 4276 and 4277 announcement was made of the discovery of a new dark ring exterior to the bright rings of Saturn, by E. Schaer at the Observatory of Geneva.

In *A.N.* 4287, R. Jarry-Desloges shows that this ring was really discovered on 1907 September 5 and 7, at his observatory on Mount Revard, by Mr. G. Fournier.

This new ring is in part verified by observations made at Greenwich with the 28-inch refractor in October of 1908 (*M.N.*, lxi., November 1908), where a dusky ring was seen partly surrounding the bright rings. Though this was unmistakable in some of the observations, nothing is said as to the real width of the new ring, except that it was narrow. The Greenwich observations were made with powers of 450-550 and 670 on the 28-inch refractor. The object was apparently not difficult.

I observed Saturn carefully a number of times in 1908 as a continuation of my work of the year before (*M.N.*, lxviii. pp. 346-368). These observations did not show anything of the new ring, though it might have escaped notice at first through my not knowing of its existence. A careful search was made for it, however, on 1909 January 12 and 19, under good conditions, when nothing suggestive of its existence was seen. In November and the first part of December my whole attention was taken up with comet photography during the time that Saturn was in good position above the horizon, and no observations were obtained of the planet.

In all the observations of 1908 the rings of Saturn were carefully examined in hopes of finding something that would explain the presence of the luminous condensations seen on the dark part of the rings in 1907. When the conditions were good, therefore, the exterior dark ring ought to have been seen had it been as bright as when observed at Geneva and Greenwich.

As the observations of 1908 have a special bearing on some of the problems connected with the rings of Saturn, and especially with respect to this reported new dark ring, I will give them here, omitting those which, from poor conditions of seeing, are not important.

1908 July 19. Beautiful definition, magnifying power 700. The crape ring was unusually bright and the Cassini division well seen. The rings appeared flat and thin. The inner bright ring was very feebly brighter near the Cassini division. There was nothing to suggest the cause of the condensation seen last year. The shadow of the ring on the ball and the trace of the crape ring were well seen. The shadow of the ball was sharp and black. The south polar cap was quite dark. The ball was decidedly brighter than the rings.

Aug. 4. Definition good. The south polar cap was quite

dark and the crape ring very conspicuous. The outer ring at the ansæ appeared to be brighter than any part of the inner bright ring. There was nothing to suggest any cause for the condensations of last year. The only things at all suggestive were the crape ring and the Cassini division. The latter was not very well seen. Magnifying power 700.

Aug. 16. The southern cap was dark. The outer ring seemed to be brighter than the inner ring at the ansæ when best seen. The crape ring was quite bright.

Sept. 15. Seeing very good. The crape ring was quite easy. The south polar region was dark.

Sept. 20. Seeing very good. South polar region darkish. The crape ring quite bright. The rings looked very thin. At the ansæ the outer ring was the brighter of the two. Close south of the trace of the ring on the ball was a narrow line of shadow (shadow of rings). It was partly shadow and partly trace of the crape ring. The shadow was a thin edging to the south part of the trace of the rings, and lay close in between the inner edge of the bright rings and the edge of the crape ring. It must therefore have been seen wholly through the crape ring.

Oct. 6. Seeing fair. The crape ring was quite bright. Could see traces of the shadow of the rings on the ball towards the edges of the ball. This shadow was very thin. Could see nothing on the rings that would suggest the condensations of last year. Moisture on object-glass.

Dec. 27. Seeing good. Nothing abnormal.

1909 Jan. 12, 5^h 10^m to 5^h 40^m. Looked carefully for the new outer dark ring of Saturn. Seeing = 3 (scale of 5). Eye-pieces 460 and 700. Could see nothing of it. Specially examined at the ansæ. Occulted the planet by edge of field and by the smoked mica occulter. Nothing abnormal anywhere. The outer bright ring seemed to be a little brighter at the ansæ than the inner ring. There did not seem to be anything outside the bright rings—even close to the rings. A small satellite, south of the following ansa, was conspicuous. Observation quite satisfactory. The seeing was not perfect enough to give a sharply defined black image of the shadow of the rings on the ball.

Jan. 19, 5^h 30^m to 5^h 50^m. Examined the planet carefully with 460 and 700. Seeing = 3. No evidence of a ring exterior to the bright rings. Then cut down aperture to 35 inches. Seeing = 3 - 4, much better. The shadow of the rings on the ball was sharp and black. Nothing abnormal about the ball or rings. The outer ring seemed a little brighter at the ansæ than the inner ring—perhaps due to contrast. Could not make much out of crape ring. It did not seem to be as bright as it was several months previous.

Conclusions.

One fact that impressed me in these observations, which were all made with the 40-inch telescope, was the unusual brightness of

the crape ring. It is precisely what should have occurred, however, for the ring was seen very obliquely, and a greater brightness would result from the fact that the same number of luminous particles were compressed by perspective into a much smaller space, and must therefore appear brighter. That this must be so was pointed out by Professor W. H. Wright in a paper in the *Astrophysical Journal*, vol. xxvii. p. 364.

Another fact was the change in relative brightness between the inner and the outer bright rings. When the rings are widely opened, the inner ring is decidedly brighter than the outer one. The present observations would seem to show that when the rings are seen at a low angle the outer ring appears the brighter of the two.

This peculiarity can also be explained by a similar assumption to that above used for the crape ring. That is, that there are fewer particles, area for area, in the outer than in the inner bright ring.

It seems to me that these observations alone could almost be taken as a proof of the meteoric constitution of the rings of Saturn.

It will be remembered that the light spots or condensations on the dark side of the rings (at their disappearance in 1907) were under observation here from 1907 July 2 for nearly five months before they were seen at any other observatory. No perfectly satisfactory explanation has yet been given for these luminous condensations. Two explanations were offered by me, *M.N.*, lxviii. pp. 355 and 365, the first of which in part seems improbable; the second connected them with the crape ring and the Cassini division. I am quite satisfied (and I think the observations in the present paper bear me out) that the inner condensations were due to the sunlight sifting through and being reflected from the particles of the crape ring. The outer condensations were in some manner connected with the Cassini division, as explained in the paper referred to above. The visibility of the dark side of the rings, it appears to me, was due to the sunlight passing through among the particles composing the rings, and being diffused and reflected from the dark side. I am now inclined to attribute most of this latter effect to the outer bright ring, in which the particles must be more thinly scattered. Indeed, I believe that if the surface of the rings was turned at right angles to us, the outer ring would be comparatively dark, and the crape ring would be perhaps invisible, from the apparent widening out of the spaces between the particles.

It is needless to say that the condensations were not due to thicker places on the rings. This was emphatically disproved by my observations both in July and October of 1907 and in January of 1908 when the rings were on edge to us. At these times the condensations should have been the most conspicuous if they were due to greater thickness. In reality, under these conditions, they entirely disappeared.

That they were due in some manner to the transmission of the sunlight through the rings (through the crape ring and Cassini

division, perhaps) is further shown by the fact that no trace of them was seen when the bright side of the rings was presented to us at a similar low angle to that of the dark side when they were visible.

Yerkes Observatory :

1909 May 3.

On the Erroneous Results of a Stereoscopic Combination of Photographs of a Comet. By E. E. Barnard.

The stereoscope enables one to see objects in perspective by the combination of two photographs taken from a slightly different point of view. One way to accomplish this effect is to shift the position and direction of the camera by a proper amount between the taking of the two pictures. Essentially the same effect would be produced by the bodily displacement of the object with the camera stationary, provided all of the background were itself too distant for parallax displacement. Both these methods would require that there were no relative change in the individual parts of the object in the interval between the two pictures. In practice, stereoscopic pictures are made by simultaneous exposures with twin lenses separated by a few inches. For celestial bodies, where our base line is too small to give any appreciable parallax, the last of the two methods is resorted to. In the case of the Moon the perspective is obtained by the aid of libration; and as the phase has to be exactly the same, a very long interval is required. In the case of a bright asteroid an interval of an hour, or of a proper motion star of several years, will produce the required effect. The short interval is also applicable to a comet, and beautiful and startling effects are produced by this means in the case of a comet with a tail. Few bright comets, however, are above the horizon long enough to permit the two photographs to be made for this purpose. On account of its high north declination, and its consequent visibility through all or nearly all the night, comet *c* 1908 (Morehouse) was specially suited for stereoscopic photographs, and the material acquired for this purpose is abundant. The combinations of proper sets of these pictures show the comet in beautiful relief suspended alone in space, as we know it is in reality, with the various parts of the tail in individual perspective. There is a wonderful effect of reality in these pictures, and the filmy, breath-like character of the comet is shown as no single picture can even hope to show it. These photographs are marvellously instructive, and one is tempted to deduce certain "facts" from the appearance which are probably entirely erroneous.

This is such a serious matter, and one so fascinatingly delusive, that I have thought it worth while to draw attention to the chances for serious errors that are inherent in the very success of the experiment in the case of a comet.

I have combined a number of photographs of the present comet